MATHEMATICS · GRADES 10-12

Vertical and horizontal asymptotes

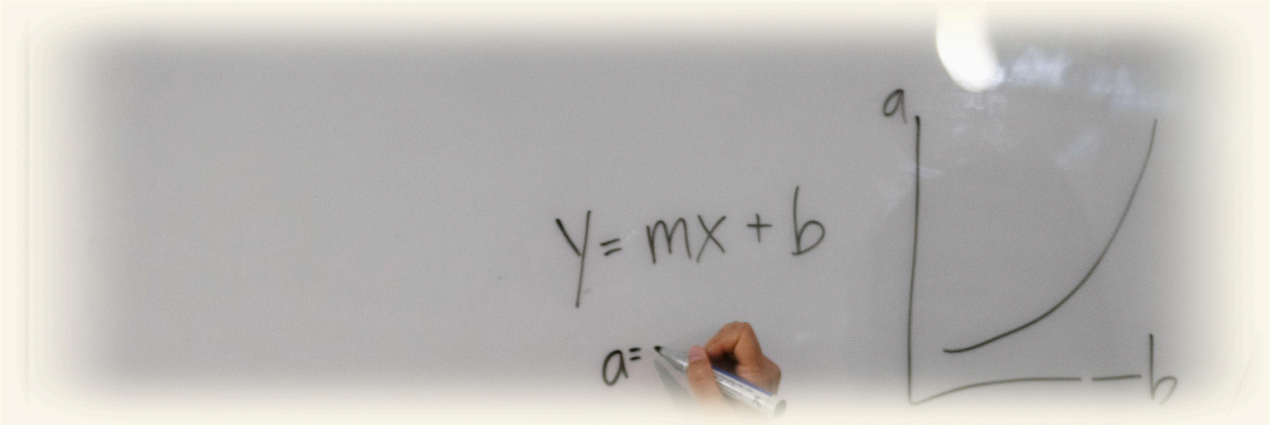
Difficulty level: Advanced

Mathematics: Grades 10-12

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Overview of the concept

This is how you describe what a graph does near its breaks and far out to the sides, like a cost per item that drops as you make more but never reaches zero, so you can sketch it correctly. A vertical asymptote is a line the graph shoots toward but never crosses, and a horizontal one is a value it approaches as you go further out. Knowing where those lines sit tells you the shape of the whole graph, even before you plot many points. That is how you sketch a curve that has breaks and limits, instead of guessing where it goes.



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Rule

Vertical and horizontal asymptotes: a vertical asymptote is where the denominator is zero, and a horizontal asymptote comes from comparing the degrees of the top and bottom.

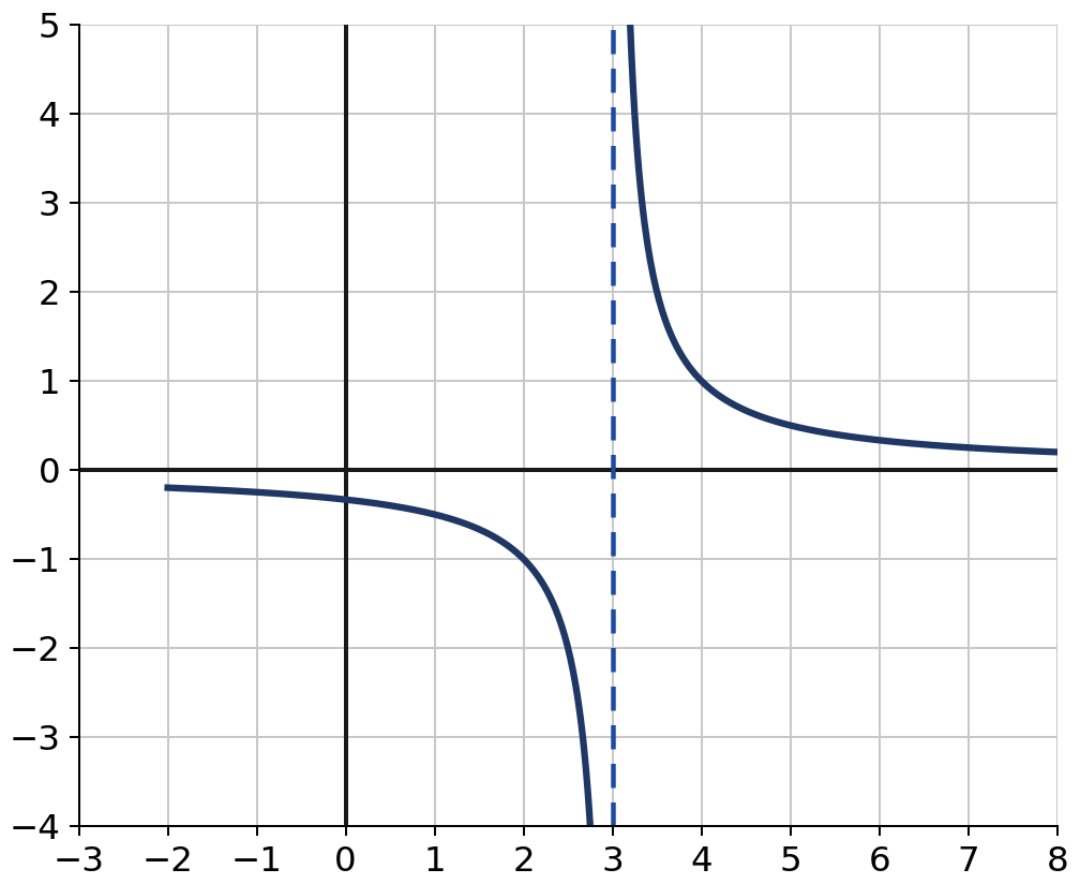
If the bottom degree is bigger, the horizontal asymptote is $y = 0$, and if the degrees are equal, it is the ratio of the leading coefficients.

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Worked examples

EXAMPLE 1

Q Find the asymptotes of $f(x) = \frac{1}{(x - 3)}$



SOLUTION

Vertical asymptote: set the denominator to zero:

$x - 3 = 0$

$x = 3$

Horizontal asymptote:

Top degree: 0, bottom degree: 1

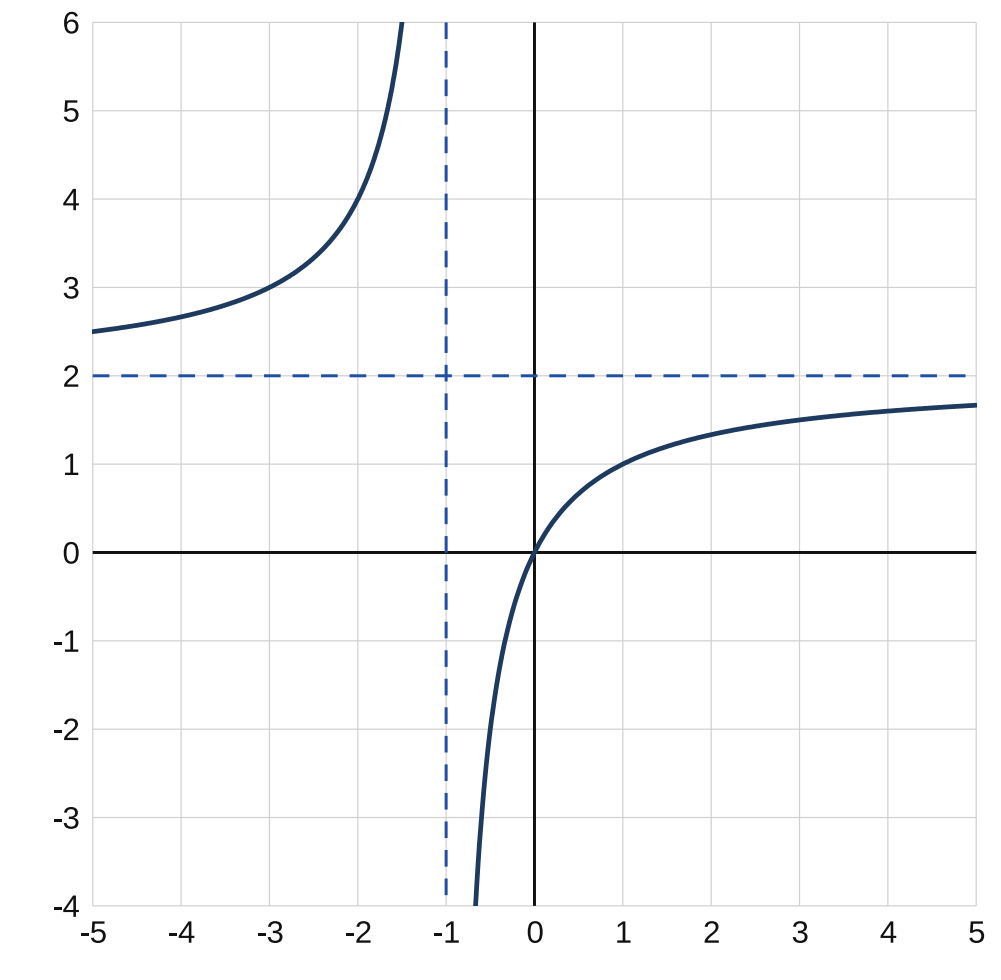
$0 < 1$, so $y = 0$

So the asymptotes are $x = 3$ and $y = 0$.

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EXAMPLE 2

Q Find the asymptotes of $f(x) = \dfrac{(2x)}{(x + 1)}$



SOLUTION

Vertical asymptote: set the denominator to zero:

$x + 1 = 0$

$x = -1$

Horizontal asymptote: the degrees are equal, so take the ratio of leading coefficients: $\dfrac{2}{1} = 2$.

So the asymptotes are $x = -1$ and $y = 2$.

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Practice questions

1 A camera's focus is $f(x) = \frac{1}{(x - 4)}$. Find the asymptotes.

- **A** x = -4 and y = 0
- **B** x = 4 and y = 0
- **C** x = 4 and y = 1
- **D** x = 0 and y = 4

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2 A lens formula is $f(x) = \frac{(3x)}{(x - 2)}$. Find the asymptotes.

- **A** x = -2 and y = 3
- **B** x = 2 and y = -3
- **C** x = 2 and y = 3
- **D** x = 3 and y = 2

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3 A recipe scales as $f(x) = \frac{1}{(x + 2)}$. Find the asymptotes.

- **A** x = -2 and y = 0
- **B** x = 2 and y = 0
- **C** x = -2 and y = 1
- **D** x = 0 and y = -2

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4 A speed formula is $f(x) = \frac{(3x)}{(x - 1)}$. Find the asymptotes.

- **A** x = -1 and y = 3
- **B** x = 1 and y = -3
- **C** x = 3 and y = 1
- **D** x = 1 and y = 3

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5 A discount is $f(x) = \frac{1}{(x - 5)}$. Find the asymptotes.

- **A** x = -5 and y = 0
- **B** x = 5 and y = 0
- **C** x = 5 and y = 1
- **D** x = 0 and y = 5

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6 A battery drains as $f(x) = \frac{x}{(x + 4)}$. Find the asymptotes.

- **A** x = -4 and y = 1
- **B** x = 4 and y = 1
- **C** x = -4 and y = -1
- **D** x = 1 and y = -4

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7 A tax formula is $f(x) = \frac{2}{(x + 3)}$. Find the asymptotes.

- **A** x = 3 and y = 0
- **B** x = -3 and y = 2
- **C** x = -3 and y = 0
- **D** x = 0 and y = -3

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8 A spring stretches as $f(x) = \frac{(4x)}{(x - 2)}$. Find the asymptotes.

- **A** x = -2 and y = 4
- **B** x = 2 and y = -4
- **C** x = 4 and y = 2
- **D** x = 2 and y = 4

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9 A signal is $f(x) = \frac{1}{(x + 7)}$. Find the asymptotes.

- **A** x = 7 and y = 0
- **B** x = -7 and y = 0
- **C** x = -7 and y = 1
- **D** x = 0 and y = -7

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10 A flow rate is $f(x) = \frac{(5x)}{(x + 1)}$. Find the asymptotes.

- **A** x = -1 and y = 5
- **B** x = 1 and y = 5
- **C** x = -1 and y = -5
- **D** x = 5 and y = -1

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ANSWER KEY

1. x = 4 and y = 0

2. x = 2 and y = 3

3. x = -2 and y = 0

4. x = 1 and y = 3

5. x = 5 and y = 0

6. x = -4 and y = 1

7. x = -3 and y = 0

8. x = 2 and y = 4

9. x = -7 and y = 0

10. x = -1 and y = 5

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